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COMPARISON OF OPENFOAM AND ELLIPSYS FOR MODELLING THE WIND RESSOURCES IN COMPLEX TERRAIN

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Introduction

Computational Fluid Dynamics (CFD) tools can now model the wind resources in complex terrain at an higher accuracy than industry standard linearized flow solvers (e.g. WAsP, ..). This increased accuracy comes at a cost that is two-fold. The complex and time consuming task of designing the computational meshes, and the solving time of the CFD tools, which is several orders of magnitude larger than the linearized flow solvers (e.g. hours instead of seconds).

Among the many different CFD tools available for modelling atmospheric flows, OpenFoam has received a growing attention from the wind research and industry during the past years. OpenFoam is a free and open source general purpose unstructured flow solver with a growing wind resource community. It recently performed very well at the Bolund blind comparison, which gave it the reputation to be well adapted for modelling the flow over complex terrain. EllipSys is a general purpose structured flow solver developed by DTU-MEK and Risø DTU during the past 20 years. It was designed from ground up to model flows over complex terrain, and has since then been applied successfully on many other types of flows.

Approach

The aim of this paper is to assess the performance of OpenFoam in comparison with EllipSys, in term of mesh generation, accuracy and computational speed. Two test cases, Asekervein and Bolund, are used to compare the two codes with wind speed and turbulence intensity measurements. The study focuses on highlighting the strength and weaknesses of OpenFoam in comparison with EllipSys. The comparison was carried out using the existing models and tools available in OpenFoam v1.7.

The novelty of this work is the focus on the computational speed and the mesh generation issues. It also gives a good idea of the challenges to expect for a new user when starting to use OpenFoam.

Main body of abstract

The results show that OpenFoam offers a wider range of mesh generation possibilities than EllipSys, as it can deal with unstructured grids. While this means, in theory, that the OpenFoam meshes can have a smaller number of cells than the structured mesh used in EllipSys, it appeared difficult do design a mesh matching the other needs of OpenFoam. In particular, the restriction of OpenFoam on the cell aspect ratio effectively restrict the potential of the unstructured mesh to reduce the number of cells compared with structured meshes.

Moreover, OpenFoam's standard wall function was found to be in unbalance with the input parameters, which can introduce errors. This specific wall function also requires the first cell height of the mesh to be 20 times larger than the roughness height. Therefore the mesh generation is largely dependent of the roughness height, in contrast with EllipSys. Nonetheless, the accuracy of the solution is found to be acceptable in comparison of both EllipSys and the measurements.

In term of computational speed, OpenFoam was found to perform consistently 5 to 10 times slower than EllipSys while using the same models and same mesh.

Conclusion

In conclusion OpenFoam presents an attractive solution, because of its open source and low cost. There are, however, currently some issues in term of mesh generation and wall-function that needs to be addressed to increase its flexibility, speed and accuracy.